

## HARD DISK SYSTEM

### CROSS REFERENCE TO RELATED APPLICATIONS

The present document claims priority to Japanese Priority  
5 Document JP 2003-002664, filed in the Japanese Patent Office on January 8,  
2003, the entire contents of which are incorporated herein by reference to  
the extent permitted by law.

### BACKGROUND OF THE INVENTION

#### 10 1. Field of the Invention

The present invention relates to a hard disk system that is used as  
external storage, for example, for a personal computer and the like.

#### 2. Description of Related Art

A hard disk drive (hereafter referred to as HDD) can store therein a  
15 large quantity of data and enables high speed access to the stored data.  
For this reason, in an information processing apparatus such as a personal  
computer and the like, the HDD plays an important role as an external  
storage apparatus. These days, taking advantage of such merits of HDDs,  
the HDD is beginning to be used as a bulk storage apparatus for storing  
20 image data, music data and the like even in such fields as AV devices and  
the like.

Conventionally, information processing apparatuses use built-in  
HDDs, external HDDs that are connected through a connection cable to the  
body of the apparatus, and the like. Recently, as more information  
25 processing apparatuses have become mobile, portable HDDs that can be  
carried freely have been proposed (for example, refer to patent document 1).

In addition, among such portable HDDs, those commonly referred to  
as portable hard disks are already being sold. Specifically, in such a  
portable hard disk, the connection between a host device is made an  
30 interface that complies with the USB (Universal Serial Bus) standard.  
Thus, in this portable hard disk, an AC adapter is unnecessary and power

can be supplied through the power line of the USB interface. Also, this portable hard disk is designed such that data can be easily written and read simply by connecting it to the host device with a connection cable, without configuring a driver.

5 [Patent Document 1]

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### SUMMARY OF THE INVENTION

10 The portable HDD described in patent document 1 mentioned above is not necessarily easy to handle since the host device and the portable HDD must be connected to each other through a dedicated connection cable. In other words, although this portable HDD itself can be carried easily, there arises the problem of always having to carry such a dedicated connection cable around.

15 On the other hand, the above-mentioned portable hard disk can be connected to a host device with a general purpose connection cable. However, for example, if the interface on the HDD side complies with the IDE (Integrated Device Electronics) standard, interface conversion becomes necessary for the interface on the host device side that is compliant with the  
20 USB standard. For this reason, the above-mentioned portable hard disk has, on its circuit board, an interface conversion circuit (IDE/USB conversion circuit) for carrying out interface conversion between the interface on the HDD side (IDE) and the interface on the host device side (USB).

25 Thus, the above-mentioned portable hard disk must be designed so as to be bigger by a margin corresponding to the size of this circuit board, thereby causing the apparatus as a whole to become larger. Also, this portable hard disk itself has an interface that complies with the USB standard. However, for an electronic device having an interface that  
30 complies with some standard other than USB, it is necessary to prepare a portable hard disk having an interface conversion circuit for the interface

that the electronic device has.

In addition, the power supply from the above-mentioned USB interface is about 500 mA. The portable hard disk requires more power the greater the capacity of the HDD is. Thus, there may be cases where the performance of the HDD must be dropped in accordance with the power which can be supplied. Such a drop in the performance of the portable hard disk causes not only a drop in performance on the host device side but also may cause unstable operations of the HDD and data storage may sometimes be impossible.

The present invention addresses the above-mentioned problems. Accordingly, there is provided a hard disk system of which an HDD of a high capacity can be carried freely and is easy to use.

A hard disk system related to an embodiment of the present invention is a hard disk system that is used as an external storage apparatus for a host device and includes a hard disk unit and a conversion unit which is attachable and detachable with respect to the hard disk unit.

The hard disk unit has: a hard disk for magnetically storing data; a recording/reading section for recording and reading data to and from the hard disk; and a hard disk side interface section for inputting and outputting the data, which is recorded to and read from the hard disk, with respect to the conversion unit through a first transfer format.

The conversion unit has: a host interface section for transmitting and receiving data, which is recorded to and read from the hard disk, to and from the host device through a second transfer format; a conversion unit side interface section for inputting and outputting data, which is recorded on and read from the hard disk, with the hard disk unit through the first transfer format; a transfer format conversion section for carrying out transfer format conversion between the first transfer format and the second transfer format, and carrying out data transfer between the host interface section and the conversion unit side interface section; and a power source section.

In the above-mentioned hard disk system, when the hard disk unit and the conversion unit are connected, the hard disk side interface section and the conversion unit side interface section carry out data transfer between each other. Also, the power source section supplies power to each section of the conversion unit when the hard disk unit and the conversion unit are connected.

A hard disk system related to an embodiment of the present invention is a hard disk system that is used as an external storage apparatus for a host device and includes a hard disk unit and a conversion unit which is attachable and detachable with respect to the hard disk unit.

The hard disk unit has: a hard disk for magnetically storing data; a recording/reading section for recording and reading data on and from the hard disk; and a hard disk side interface section for inputting and outputting data, which is recorded on and read from the hard disk, with the conversion unit through a first transfer format.

The conversion unit has: a host interface section for transmitting and receiving data, which is recorded on and read from the hard disk, to and from the host device through a second transfer format; a conversion unit side interface section for inputting and outputting data, which is recorded on and read from the hard disk, with the hard disk unit through the first transfer format; a transfer format conversion section for carrying out transfer format conversion between the first transfer format and the second transfer format, and carrying out data transfer between the host interface section and the conversion unit side interface section; a power source section; and a secondary battery.

In the above-mentioned hard disk system, when the hard disk unit and the conversion unit are connected, the hard disk side interface section and the conversion unit side interface section carry out data transfer between each other. Also, when the hard disk unit and the conversion unit are connected, the power source section supplies the combined power of the power of a power supply line of the host interface section and the power of

the secondary battery to the hard disk unit.

In a hard disk system related to the present invention, power consumption is sought to be reduced, and operation is begun when the hard disk unit and the conversion unit are securely connected.

5 In addition, in a hard disk system related to the present invention, operative power can be secured without having to provide power externally, thereby making it easier to carry.

### BRIEF DESCRIPTION OF THE DRAWINGS

10 Fig. 1 is a perspective view showing a PHD (Portable Hard Disk) unit and an adapter in use and constituting a PHD system to which the present invention is applied;

Fig. 2 is a perspective view showing a PHD unit and a cradle in use and constituting a PHD system to which the present invention is applied;

15 Fig. 3 is a perspective view showing the configuration of a PHD unit and an adapter;

Fig. 4 is an exploded perspective view showing the configuration of a PHD unit and an adapter;

20 Fig. 5A and Fig. 5B are perspective views showing the configuration of a hard disk drive;

Fig. 6 is a perspective view showing how a hard disk drive is accommodated in a first housing;

Fig. 7 is a perspective view of a main portion showing how a first connector is attached to a first housing;

25 Fig. 8 is an electrical inner configuration view of a PHD unit;

Fig. 9 is a perspective view showing the configuration of an adapter;

Fig. 10 is a plan view of a main portion of an adapter showing its attachment structure;

Fig. 11 is an electrical inner configuration view of an adapter;

30 Fig. 12 is a plan view showing a PHD unit and an adapter as attached;

Fig. 13 is a perspective view showing the configuration of a PHD unit and a cradle;

Fig. 14 is an exploded perspective view showing the configuration of a cradle;

5 Fig. 15 is a perspective view showing the configuration of a lock mechanism and an unlocking mechanism;

Fig. 16 is a perspective view showing a switch being operated by the unlocking mechanism;

10 Fig. 17 is a perspective view showing a condition where the lock mechanism has been released by the unlocking mechanism; and

Fig. 18 is an electrical inner configuration view of a cradle.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 A hard disk system, a hard disk unit and a conversion unit to which the present invention is applied will be described below with reference to the attached drawings.

A hard disk system to which the present invention is applied is a portable hard disk system (hereafter referred to as a PHD system) that is provided with, as shown in Figs. 1 and 2: a portable hard disk unit  
20 (hereafter referred to as a PHD unit) 1; and an adapter 2 or a cradle 3 serving as a conversion unit.

More specifically, in the PHD system shown in Fig. 1, the PHD unit 1 is electrically connected to, for example, a notebook personal computer 4 serving as a host device via a connection cable 5 in a state where the adapter  
25 2 is attached to the PHD unit 1. Thus, data is written and read between the PHD unit 1 and the host device 4.

On the other hand, in the PHD system shown in Fig. 2, the PHD unit 1 is electrically connected to, for example, a desktop personal computer 6 serving as a host device through a connection cable 7 in a state where the  
30 PHD unit 1 is mounted on the cradle 3. Thus, data is written and read between the PHD unit 1 and the host device 6.

The PHD system shown in Fig. 1 is an embodiment that is suitable for handling data between a portable host device that can be used outdoors. The PHD system shown in Fig. 2 is an embodiment that is suitable for handling data between a desktop host device that is used mostly indoors. Thus, in the above-mentioned PHD system, it is possible to easily alter the combination of the PHD unit 1 and the adapter 2 or the cradle 3, depending on how the system is used.

First, the PHD unit 1 of the PHD system shown in Figs. 1 and 2 will be described below.

As shown in Figs. 3, 4 and 5, the PHD unit 1 is provided with: a first housing 8; a hard disk drive (hereafter referred to as HDD) 9 serving as a recording/reading section accommodated in this first housing 8; a first connector 10 that is electrically connected to this HDD 9 and faces outside from the first housing 8; a plurality of cushioning members 11 placed between the first housing 8 and the HDD 9; and a pair of upper and lower electro-magnetic shielding plates 12 for shielding the HDD 9.

The first housing 8 is a plastic case formed of a resin material through injection molding, and it has a structure in which an upper half 8a and a lower half 8b, each having the shape of an approximately flat box, are joined and integrated with a plurality of screws 13 into a single unit in a condition where the upper and lower halves 8a and 8b are made to face each other at their respective side walls. A space in which the HDD 9 is to be accommodated is formed inside this first housing 8, and the shape thereof resembles an approximately rectangular plate corresponding to the HDD 9.

Also, one of the shorter sides of the first housing 8 forms a connection plane 8c to be connected to the adapter 2 and the cradle 3, which will be described later. An engagement recess 14 with which engagement protrusions of the adapter 2 and the cradle 3 described later are engaged is formed in an approximately central position of this connection plane 8c. Also, an opening 15 through which the first connector 10 is exposed outward is formed on the bottom surface of this engagement recess 14.

On this connection plane 8c, a positioning hole 16 serving as a first positioning section is formed on one side, and a fixing plate 17 serving as a first fixing section is provided on the other side with the first connector 10 between the positioning hole 16 and the fixing plate 17. The positioning  
5 hole 16 is formed so as to lead to an internal space in one corner separated from the space in the first housing 8 in which the HDD 9 is accommodated. The fixing plate 17 is positioned and fixed in an internal space in another corner separated from the space in the first housing 8 in which the HDD 9 is accommodated. Then, a screw hole 17a is formed in this fixing plate 17 in  
10 alignment with a hole formed in the first housing 8.

In addition, a first displaying section 18 for classifying and displaying the storage capacity of the HDD 9 by text or color is formed on the principal surface of the upper half 8a. This first displaying section 18 is devised so as to conceal gate marks generated when the first housing 8 is  
15 injection molded. In other words, on the upper half 8a of the first housing 8, a gate mark is generated approximately in a center portion towards the connection plane 8c. However, by forming the first displaying section 18 at such a position that this gate mark would be covered, the design is improved. In addition, this first displaying section 18 is formed in a substantially  
20 linear manner from where this gate mark is formed towards the end on the side of the connection plane 8c.

On the other hand, an engagement recess section 19 for maintaining a state where the PHD unit 1 is mounted on a mounting section 60 of the cradle 3, which will be described later, is formed on the principal surface of  
25 the lower half 8b. This engagement recess section 19 is formed in the shape of an approximate rectangle of a predetermined depth and at a position on the lower half 8b facing an engagement protrusion 73b of the cradle 3.

In addition, a pair of guide grooves 20 (first guiding sections), which  
30 guides the PHD unit 1 in mounting it on the mounting section 60 of the cradle 3, is formed on the elongate sides of the lower half 8b. Each guide



groove 20 of the pair is formed from the end section on the side of the connection plane 8c of the lower half 8b up to some point in the middle towards the other end. Moreover, a plurality of rubber pads 21 serving as slip stoppers are provided on the principal surface of the lower half 8b in its corner sections.

As shown in Figs. 5A and 5B, within a space formed by a chassis 22 and a top cover 23, the HDD 9 has: a hard disk 24 that is a magnetic disk; a spindle motor 25 serving as a rotating means for rotating this hard disk 24; a magnetic head 26 for recording and reading data on and from the hard disk 24; and a head actuator 27 serving as a head actuating means for actuating the magnetic head 26 in the radial direction of the hard disk 24 by supporting the magnetic head 26 at its tip and being moved with its base end as a fulcrum. Also, on the back side of the chassis 22 of the HDD 9 is attached a circuit board 28 including a control circuit for controlling the above-mentioned mechanisms and for controlling the recording and reproducing by the magnetic head 26 with respect to the hard disk 24. In addition, connector pins 29 serving as an interface of the HDD 9, which for example complies with the IDE standard, are attached to this circuit board 28 in such a way that they face outward from one of the shorter sides of the chassis 22.

As shown in Figs. 6 and 7, the first connector 10 is a male connector, which matches the signal pin arrangement of the above-mentioned interface of the HDD 9 that complies with the above-mentioned IDE standard but is made smaller. This first connector 10 is attached within the plane of the opening 15 of the above-mentioned first housing 8 with some allowance for movement, in other words, in a semi-fixed state. Specifically, this first connector 10 has an engagement groove 30 with which portions constituting the opening 15 of the above-mentioned upper half 8a and lower half 8b are engaged, and this engagement groove 30 is formed over the periphery of the first connector 10. By having the portions of the upper and lower halves 8a and 8b that constitute the opening 15 be engaged with the engagement

groove 30, this first connector 10 is held in a state where it is semi-engaged with the opening 15 of the first housing 8 in which the upper half 8a and the lower half 8b face each other. Thus, this first connector 10 can be moved slightly within the plane of the opening 15 of the first housing 8.

5           This first connector 10 is electrically connected to the connector pins 29 of the HDD 9 through a flexible cable 31. This flexible cable 31 is shaped such that it tapers as it approaches the first connector 10 from the connector pins 29, and it is placed so as to be in the shape of an approximate inverted U between the connector pins 29 and the first connector 10. Thus,  
10   the first connector 10 is biased outward from the first housing 8 by the elastic force of this flexible cable 31. Consequently, it is possible to suppress unsteadiness in connecting the first connector 10 to second connectors 43 and 46 of the adapter 2 and the cradle 3, which will be described later, thereby improving the reliability of the connection between  
15   the first connector 10 and the second connectors 43 and 46.

          The cushioning members 11 are so placed as to be engaged with the four corners of the HDD 9. Thus, when this HDD 9 is accommodated in the first housing 8, they can absorb shock, vibration and the like from outside, thereby preventing the occurrence of damage and the like to the HDD 9,  
20   while also enabling stable recording and reading of data. For the cushioning members 11, it is possible to use a visco-elastic material such as rubber having elasticity, a gel substance and the like, and in some cases a metal spring such as a coil spring, a plate spring and the like may also be used.

25           The pair of upper and lower electro-magnetic shielding plates 12 is made of approximately rectangular metal plates that match the shape of the HDD 9. They shield both principal surfaces of the HDD 9, while also shielding the sides of this HDD 9 with a plurality of bent pieces 32 bent along the sides of the HDD 9 except for the side of the HDD 9 from which the  
30   above-mentioned connector pins 29 are exposed, wherein the bent pieces 32 of the upper and lower electro-magnetic shielding plates overlap each other.

Consequently, electro-magnetic waves radiated from the HDD 9 can be shielded appropriately inside the first housing 8. Also, in the pair of upper and lower electro-magnetic shielding plates 12, a plurality of slits 32a is formed in the bent pieces 32. Thus, the connective condition of the bent  
5 pieces 32 with one another can be improved, and the shielding effect with respect to electro-magnetic waves can be improved.

The first housing 8 can be made lighter by using a plastic case formed by injection molding a resin material. Moreover, a conductive layer composed of a conductive film or the like may be formed on at least one of  
10 the principal surface of each of the upper half 8a and the lower half 8b facing the electro-magnetic shielding plates 12 and the principal surface on the side opposite that principal surface. This makes it possible to further improve the shielding effect for electro-magnetic waves. Alternatively, the first housing 8 may be formed by injection molding a resin material in which  
15 a conductive filler is contained. In this case, it is possible to improve the shielding effect for the electro-magnetic waves without having to provide an additional component.

The electrical configuration of the PHD unit 1 will be described below.

As shown in Fig. 8, the PHD unit 1 is provided with: the hard disk 24 on which data is magnetically recorded as mentioned above; the spindle motor 25 for rotationally driving this hard disk 24; the magnetic head 26 for writing and reading data on and from the hard disk 24; and the head actuator 27, to which the magnetic head 26 is attached at its tip end, that  
20 turns with its base end as a fulcrum.

The spindle motor 25 rotates the hard disk 24. The magnetic head 26 is moved in the radial direction on the circular principal surface of the hard disk 24 by the head actuator 27, thereby carrying out magnetic recording and magnetic reading of data on and from a desired position on  
25 the rotating hard disk 24.

In addition, the PHD unit 1 includes: a head amplifier circuit 101 for

driving the magnetic head 26 and detecting signals; a read/write circuit 102 for carrying out record data processing and read data processing; an IDE interface (I/F) circuit 103 for transmitting and receiving IDE format data; a servo circuit 104 for carrying out servo control processing; and a system controller 105.

At the time of recording, the head amplifier circuit 101 amplifies record data received from the read/write circuit 102 to generate write signals, and drives the magnetic head 26 based on of these write signals. At the time of recording, the magnetic head 26 is driven by the write signal, thereby generating a magnetic field corresponding to the write signal and records data on the hard disk 24. In addition, at the time of reading, the magnetic head 26 detects the magnetic field recorded on the hard disk 24, and generates a read signal corresponding to that magnetic field. At the time of reading, the head amplifier circuit 101 receives the read signal generated by the magnetic head 26, performs an amplifying process, a binarizing process and the like on the read signal, and generates read data, and then supplies the read data to the read/write circuit 102.

At the time of recording, the read/write circuit 102 performs various record data processing with respect to the record data inputted from the IDE interface circuit 103, such as a process of adding an error correction code, modulation processing and the like, and supplies the record data to the head amplifier circuit 101. At the time of reading, the read/write circuit 102 performs various read data processing with respect to the read data inputted from the head amplifier circuit 101, such as demodulation processing, an error correcting process and the like, and supplies to the IDE interface circuit 103 the read data on which the above-mentioned read data processing has been performed.

At the time of recording, the IDE interface circuit 103 receives IDE data from the adapter 2 or the cradle 3 via the first connector 10, converts the received IDE data into record data, and supplies it to the read/write circuit 102. At the time of reading, the IDE interface circuit 103 receives

read data from the read/write circuit 102, converts this read data into IDE data, and outputs it to the adapter 2 or the cradle 3 via the first connector 10. Also, the IDE interface circuit 103 supplies control information transferred from the adapter 2 or the cradle 3 in the IDE format to the system controller 105, and transfers control information supplied from the system controller 105 to the adapter 2 or the cradle 3 in the IDE format.

The servo circuit 104 carries out rotational drive control for the spindle motor 25 and actuation control for the head actuator 27 based on an error signal detected by the head amplifier circuit 101 and the like and on position control information given by the system controller 105 and the like, and records and reads data on and from a predetermined position on the hard disk 24.

The system controller 105 controls the servo circuit 104 and the like based on read data and record data of the read/write circuit 102 and the various control information from the host devices 4 and 6 supplied via the IDE interface circuit 103.

In addition, a jumper cable 106 is provided in the PHD unit 1. First and second USB power source pins 107 and 108, which are not required of an IDE interface bus, together with a transmission line which is required of an IDE interface bus, are provided in the first connector 10. The jumper cable 106 is a connection line for electrically short-circuiting the first USB power source pin 107 and the second USB power source pin 108. When the adapter 2 or the cradle 3 is connected, the jumper cable 106 functions as a power switch. Its function will be described later in detail.

In the PHD unit 1 having the above-mentioned configuration, the record data transferred from the host devices 4 and 6 can be written on the hard disk 24, and data thus written can be stored. Also, in the PHD unit 1, the data stored in the hard disk 24 can be read out and transferred to the host devices 4 and 6. Thus, the PHD unit 1 functions as an external storage apparatus for the host devices 4 and 6.

The adapter 2, which, together with the PHD unit 1 mentioned

above, forms part of the PHD system shown in Fig. 1, will be described below.

As shown in Figs. 3, 4 and 9, the adapter 2 has: a second housing 40; a battery 41 and a circuit board 42 which are accommodated in the second housing 40; a second connector 43, a USB connector 44 and a power jack 45 which are mounted on the circuit board 42 and face outward from the second housing 40; and a pair of upper and lower electro-magnetic shielding plates 46 for shielding the circuit board 42.

The second housing 40 is a plastic case formed by injection molding a resin material, and it has a structure where an upper half 40a and a lower half 40b, each having the shape of an approximately flat box, are joined and integrated into a single unit with a plurality of screws 47, in a state where the upper and lower halves 40a and 40b are made to face each other at their respective side walls. A space in which the battery 41 and the circuit board 42 are to be accommodated is formed inside this second housing 40, and the shape the second housing 40 resembles an approximately rectangular plate corresponding to the first housing 8 so as to match the PHD unit 1 mentioned above.

Also, one of the longer sides of the second housing 40 forms a connection plane 40c to be connected to the above-mentioned PHD unit 1. An engagement protrusion 48 to be engaged with the engagement recess 14 of the above-mentioned PHD unit 1 is formed approximately in the center of this connection plane 40c. Also, an opening 49 from which the second connector 43 faces outward is formed on the top surface of this engagement recess 48.

Also, on this connection plane 40c, a positioning protrusion 50 serving as a second positioning section is formed to one side of the second connector 43, and a screw member 51 and a protruding section 52, which serve as a second fixing section, are formed to the other side of the second connector 43.

The positioning protrusion 50 is formed at a position where it would

be engaged with the above-mentioned positioning hole 16 when the first connector 10 and the second connector 43 are connected.

As shown in Figs. 4 and 10, the screw member 51 has a rotative operation section 51a that is rotationally operated and a screw section 51b that is screwed into the screw hole 17a of the above-mentioned fixing plate 17. The screw member 51 is rotatably accommodated in an internal space in a corner separated from the space in which the circuit board 42 and the battery 41 are accommodated inside the second housing 40. Also, an operation window 53 from which the rotative operation section 51a is exposed is formed on the lower half 40b. Also, the screw section 51b protrudes outward from a hole formed in the connection plane 40c of the second housing 40.

The protruding section 52 has a slanted plane 52a of which one side is taller by a predetermined height s than the other side thereof.

In addition, a second displaying section 54 for classifying and displaying the interface on the side of the host device 4 by text and color is formed on a principal surface of the upper half 40a. This second displaying section 54 is devised so as to conceal gate marks generated when the second housing 40 is injection molded. In other words, on the upper half 40a of the second housing 40, a gate mark is generated approximately in a center portion towards the connection plane 40c. However, by forming the second displaying section 54 at such a position that this gate mark would be covered, the design is improved. In addition, this second displaying section 54 is formed in a substantially linear manner from where this gate mark is formed towards the end on the side of the connection plane 40c. Also, an LED (Light Emitting Diode) 55 for indicating a condition where the adapter 2 is connected to the PHD unit 1, the operative condition of the PHD unit 1 and the like is provided on this second displaying section 54.

The battery 41 is electrically connected to the circuit board 42 and placed inside the second housing 40 so that one overlaps the other. This battery 41 serves as an inner power source and supplies power to the PHD

unit 1.

The second connector 43 mounted on the circuit board 42 is a female connector corresponding to the interface on the side of the PHD unit 1 that complies with the signal pin arrangement of the above-mentioned IDE standard. This second connector 43 is attached in a state where it is engaged with the opening 49 of the above-mentioned second housing 40, that is, in a fixed condition. By being connected to the first connector 10 of the PHD unit 1 mentioned above, the second connector 43 is able to supply power to the PHD unit 1, and transmit and receive data to and from the PHD unit 1.

The USB connector 44 mounted on the circuit board 42 is a transmission/reception unit corresponding to the interface on the side of the host device 4 that complies with, for example, the USB standard, and is provided so as to face outward from the side section opposite the connection plane 40c of the second housing 40 mentioned above. By being connected to the host device 4 via the connection cable 5, the USB connector 44 is able to receive power supplied from the host device 4, and to transmit and receive data to and from the host device 4.

In addition, this circuit board 42 includes an interface conversion circuit (IDE/USB conversion circuit) serving as an interface converter for carrying out interface conversion between the PHD interface (IDE) and the host device 4 interface (USB) between the above-mentioned second connector 43 and USB connector 44. Consequently, power can be supplied from the host device 4 to the PHD unit 1, and the reading and/or writing of data is made possible.

Also, the power source jack 45 mounted on the circuit board 42 is provided such that it faces outward from the side section opposite the connection plane 40c of the second housing 40, and is provided alongside the above-mentioned USB connector 44. By having an AC adapter connected to the power source jack 45, power can be supplied to the PHD unit 1 from an external power source, and the battery 41 can be charged.



In addition, this circuit board 42 includes a control circuit for controlling the supplying of power to the PHD unit 1 and the charging of the battery 41.

The pair of upper and lower electro-magnetic shielding plates 46 includes approximately rectangular metal plates corresponding to the shape of the circuit board 42. They shield both principal surfaces of the circuit board 42 on which the second connector 43, the USB connector 44 and the power source jack 45 are mounted, and are grounded in relation to the circuit board 42. Also, the pair of upper and lower electro-magnetic shielding plates 46 shields this circuit board 42 in a state where a plurality of bent pieces 56 bent along the circuit board 42 are bent and laid over each other. Thus, electro-magnetic waves radiated from the circuit board 42 can be suitably shielded inside the second housing 40. Also, in the pair of upper and lower electro-magnetic shielding plates 46, by forming a plurality of slits 56a in the bent pieces 56 along the direction in which they are bent, the contact condition between the respective bent pieces 56 is improved, thereby making it possible to further improve the shielding effect for electro-magnetic waves.

The second housing 40 can be made lighter by using a plastic case formed by injection molding a resin material. Moreover, a conductive layer composed of a conductive film or the like may be formed on at least one of the principal surface of each of the upper half 40a and the lower half 40b facing the electro-magnetic shielding plates 46 and the principal surface on the side opposite that principal surface. This makes it possible to further improve the shielding effect for electro-magnetic waves. Alternatively, the second housing 40 may be formed by injection molding a resin material in which a conductive filler is contained. In this case, it is possible to improve the shielding effect for electro-magnetic waves without having to provide an additional component.

The electrical configuration of the adapter 2 will be described below.

As shown in Fig. 11, the adapter 2 includes a USB interface (I/F)

circuit 111, an IDE interface (I/F) circuit 112 and a USB/IDE conversion circuit 113.

The USB interface circuit 111 is an interface circuit for transmitting and receiving data in USB format to and from the host device 4 through the USB connector 44. The IDE interface circuit 112 is the interface circuit for transmitting and receiving data in IDE format to and from the PHD unit 1 through the second connector 43. The USB/IDE conversion circuit 113 is a circuit for carrying out conversion from data of USB format into data of IDE format and vice versa.

In the adapter 2 having the above-mentioned configuration, the USB interface circuit 111 receives data in USB format transferred from the host device 4 through the USB connector 44. The USB interface circuit 111 transfers the data in USB format received from the host device 4 to the USB/IDE conversion circuit 113. The USB/IDE conversion circuit 113 converts the data in USB format transferred from the USB interface circuit 111 into data in IDE format, and transfers it to the IDE interface circuit 112. The IDE interface circuit 112 transfers the data in IDE format to the PHD unit 1 via the second connector 43. Thus, in the adapter 2, it is possible to convert data received in USB format from the host device 4 into IDE format data, transfer it to the PHD unit 1, and record the data on the hard disk 24 in the PHD unit 1.

In addition, in the adapter 2, the IDE interface circuit 112 receives data in IDE format transferred from the PHD unit 1 through the second connector 43. The IDE interface circuit 112 transfers the data in IDE format received from the PHD unit 1 to the USB/IDE conversion circuit 113. The USB/IDE conversion circuit 113 converts the data in IDE format transferred from the IDE interface circuit 112 into data in USB format, and transfers it to the USB interface circuit 111. The USB interface circuit 111 transmits the data in USB format to the host device 4 via the USB connector 44. Thus, in the adapter 2, it is possible to convert data of IDE format read from the hard disk 24 in the PHD unit 1 into data of USB format, and

transmit it to the host device 4.

In addition, the adapter 2 includes a DC/DC converter 114 for supplying power to the PHD unit 1.

The DC/DC converter 114 is a direct current voltage conversion  
5 circuit, such as a so-called switching converter and the like, and is capable of  
generating a voltage stabilized at a predetermined value regardless of the  
load. A direct current voltage (VCC) outputted from the DC/DC converter  
114 is supplied as direct current power that complies with the IDE standard  
to the PHD unit 1 through the second connector 43 together with data that  
10 is inputted and outputted through the IDE interface circuit 112.

The power supplied to this DC/DC converter 114 is USB power  
(V\_USB) transmitted from the host device 4 through a power line of the USB  
interface, external power (V\_IN) received from an external power source (for  
example, a converting apparatus for converting AC power into DC power),  
15 and battery power (V\_BATT) generated by the battery 41 provided inside  
the adapter 2. Hereafter, the power input terminal of the DC/DC converter  
114 is referred to as input terminal A, and the circuit configuration around  
the DC/DC converter 114 will be described below.

First and second USB power source pins 115 and 116, which are not  
20 required of an IDE interface bus, together with pins matching the  
transmission line required of an IDE interface are provided in the second  
connector 43. The first USB power source pin 115 is connected to the USB  
power line, which is a power line that is USB compliant, via the USB  
interface circuit 111. The second USB power source pin 116 is connected to  
25 the input terminal A of the DC/DC converter 114 through a diode 117. The  
diode 117 has its cathode connected to the input terminal A, thereby  
preventing a reverse flow to the USB power line.

The first and second USB power source pins 115 and 116 are  
connected to the first and second USB power source pins 107 and 108 on the  
30 side of the PHD unit 1, respectively, when the adapter 2 is connected to the  
PHD unit 1, that is, when the first connector 10 and the second connector 43

are connected. The first and second USB power source pins 107 and 108 on the side of the PHD unit 1 are short-circuited inside the PHD unit 1 with the jumper cable 106. Thus, when the adapter 2 is connected to the PHD unit 1, the first USB power source pin 115 and the second USB power source pin  
5 116 are electrically connected. Thus, when the adapter 2 is connected to the PHD unit 1 and the host device 4 and the adapter 2 are connected through the USB cable 5, USB power (V\_USB) is supplied to the DC/DC converter 114.

The power source jack 45 is connected to the input terminal A of the  
10 DC/DC converter 114 via a diode 118. The diode 118 has its cathode connected to the input terminal A, thereby preventing counter currents to the external power source. Thus, when the external power source is connected, external power (V\_IN) is supplied to the DC/DC converter 114.

The battery 41 has its negative terminal grounded. The battery 41  
15 has its positive terminal connected to the input terminal A of the DC/DC converter 114 via a mode switch 120, a battery switch 121 and a diode 122 which are connected in series. The diode 122 has its cathode connected to the input terminal A. In other words, the mode switch 120 and the battery switch 121 are connected in series between the anode of the diode 122 and  
20 the positive terminal of the battery 41. Thus, counter currents to the battery 41 from the input terminal A is prevented.

The mode switch 120 is a switch for switching between on (closed) and off (open) on the basis of an insertion detection signal indicating whether or not an output plug of the external power source is inserted into  
25 the power source jack 45. The mode switch 120 becomes off when the output plug of the external power source is inserted into the power source jack 45. The mode switch 120 becomes on when the output plug of the external power source is not inserted into the power source jack 45. The state where the output plug of the external power source is inserted into the  
30 power source jack 45 is referred to as recharge mode, and the state where the output plug of the external power source is not inserted into the power

source jack 45 is referred to as discharge mode.

The battery switch 121 switches between on (closed) and off (open) on the basis of the state of the voltage at the input terminal A of the DC/DC converter 114 supplied through the diode 118. The battery switch 121 becomes on when a voltage is applied to the input terminal A (that is, when USB electric power (V\_USB) or external electric power (V\_IN) is supplied), and it becomes off when a voltage is not applied to the input terminal A.

Thus, in discharge mode, the combined power of USB power (V\_USB) and battery power (V\_BATT) is supplied to the DC/DC converter 114. Also, in recharge mode, the combined power of external power (V\_IN) and USB power (V\_USB) is supplied to the DC/DC converter 114. A circuit configuration in which only external power (V\_IN) is supplied to the DC/DC converter 114 in recharge mode may be adopted.

One end of a charging switch 123 is connected to the positive terminal of the battery 41. The other end of the charging switch 123 is connected to the power source jack 45 via a diode 124 and to the second USB power source pin 116 of the second connector 43 via a diode 125. Cathodes of the diodes 124 and 125 are both connected to the charging switch 123, thereby preventing counter currents from the battery 41 to the external power source and the USB power line. The charging switch 123 switches between on (closed) and off (open) on the basis of a control signal. Thus, when the charging switch 123 is on, the battery 41 is charged with USB power (V\_USB) and external power (V\_IN).

In addition, the adapter 2 may have a temperature sensor 126, a capacity sensor 127 and a controller 128.

The temperature sensor 126 is a sensor for detecting the temperature of the battery 41. The capacity sensor 127 is a sensor for detecting the capacity of the battery 41.

The controller 128 controls the supplying of power to the USB interface circuit 111, the IDE interface circuit 112, the USB/IDE conversion circuit 113, the DC/DC converter 114 and the like, and controls the charging

switch 123, and the like. The second USB power source pin 116 of the second connector 43 is connected to the controller 128. The controller 128 judges the state of the voltage of this second USB power source pin 116 and controls the supplying of power as mentioned above. Also, the controller  
5 128 carries out drive control for the LED 55.

The power supply operation of the adapter 2 having the above-mentioned configuration, and the various control operations will be described below.

The adapter 2 is a system that carries out switching control of power  
10 supply by way of apparatus connection in such a way that power is not supplied unless the host device 4 and the PHD unit 1 are securely connected. The controller 128 detects the voltage of the second USB power source pin 116 of the second connector 43, and when the voltage is detected, it controls the supplying of power to the USB interface circuit 111, the IDE interface  
15 circuit 112, the USB/IDE conversion circuit 113 and the like. Through such control, the adapter 2 is made a system that does not supply power unless the host device 4 and the PHD unit 1 are connected securely. Thus, in the adapter 2, for example, even when only an external power source is connected, or a cable which should not have been connected is erroneously  
20 connected, there is no risk that unusual power related circumstances would occur. A switch for turning external power (V\_IN) from the power source jack 45 on and off may be provided, and such control where that switch is turned on when the voltage of the second USB power source pin 116 is detected may be performed.

25 Also, in the adapter 2, the mode switch 120 is off in recharge mode (the mode in which the plug of the external power source is connected to the power source jack 45), and external power (V\_IN) and USB power (V\_USB) are supplied to the PHD unit 1. Also, in recharge mode, external power (V\_IN) and USB power (V\_USB) are supplied to the battery 41, and  
30 recharging is carried out. Hence, if an external power source is connected, the battery 41 is charged without the user being consciously aware of it.

In addition, in the adapter 2, the mode switch 120 is on in discharge mode (the mode in which the plug of the external power source is not connected to the power source jack 45), and the combined power of USB power (V\_USB) and battery power (V\_BATT) is supplied to the PHD unit 1.

5 Thus, even if a data transfer bus whose power line has a small power capacity is used to carry out transmission/reception with the host device 4, the shortage can be compensated for with the battery power (V\_BATT) generated by the battery 41. Thus, even if an external power source is not carried around together, this portable hard disk can be used, thereby  
10 improving its portability.

In addition, in discharge mode, USB power (V\_USB) is supplied to the battery 41. The adapter 2 supplies a stable voltage to the PHD unit 1 using the DC/DC converter 114. Thus, if the drive load of the DC/DC converter 114 is substantial (such as when the PHD unit 1 is operated),  
15 power is pulled to the DC/DC converter 114 from the battery 41. However, when the drive load of the DC/DC converter 114 is light (such as when the PHD unit 1 is not operating), power is not discharged from the battery 41, and some power of the USB power (V\_USB) is left over. Thus, even in discharge mode, the power of the USB electric power (V\_USB) that is left  
20 over charges the battery 41. Typically, even if an information storage apparatus and a computer are connected, it is not always the case that the information storage apparatus is operating, and often times the information storage apparatus is not operating. Thus, charging can be performed more efficiently by adopting such a circuit configuration where the excess power of  
25 the USB electric power (V\_USB) is used to charge the battery 41 as mentioned above.

In addition, the adapter 2 carries out deterioration prevention and safety measures for the battery 41 by controlling the power source in accordance with the temperature of the battery 41. When the temperature  
30 of the battery 41 detected by the temperature sensor 126 becomes equal to or greater than a first temperature, the controller 128 turns off the charging

switch 123 and terminates charging. Also, when the temperature of the battery 41 becomes equal to or greater than a second temperature (it is preferable that the second temperature be set to a value higher than the first temperature), the operation itself of the adapter 2 is stopped.

5           In addition, the adapter 2 manages the capacity of the battery 41, and prevents the PHD unit 1 from suddenly stopping operating due to the battery 41 running out. When the capacity of the battery 41 detected by the capacity sensor 127 becomes equal to or less than a first threshold, the controller 128 notifies the host device 4 with warning information through  
10 the USB interface circuit 111. When notified with warning information, the host device 4, for example, may display on the screen the fact that the battery 41 is running low, or may give an audio notification of the same fact. Also, when the capacity of the battery 41 detected by the capacity sensor 127 becomes equal to or less than a second threshold (the second threshold is a  
15 value that is smaller than the first threshold), the controller 128 carries out control to stop the operation of the adapter 2 altogether. As mentioned above, by preventing the operation from suddenly stopping due to a drop in the capacity of the battery 41, it is possible to prevent data from being corrupted by a sudden stop in operation during the process of writing to or  
20 reading from the hard disk.

          In addition, the adapter 2 manages the capacity of the battery 41, and when the battery 41 is fully charged, it turns off the charging switch 123 and stops the charging operation.

          In addition, when operation is stopped because the temperature of  
25 the battery 41 is at or above the second temperature, because the capacity of the battery 41 is equal to or less than the second threshold value, or due to some other control, the controller 128, for example, watches for a communication flag (a flag generated when data is being transferred) generated by the USB/IDE conversion circuit 113, and carries out an  
30 operation stopping process at a point when the host device 4 is not writing nor reading data. The execution of such a process can protect data from



being corrupted by having operation stopped during the process of writing to or reading from the hard disk.

In addition, the controller 128 can notify the user of the operative status of the adapter 2 by carrying out display control of the LED 55. For example, the controller 128 may turn on the LED 55 if the host device 4 and the PHD unit 1 are connected to the adapter 2. In addition, the controller 128 may, for example, watch for a communication flag (a flag generated when data is being transferred) generated by the USB/IDE conversion circuit 113, and make the LED 55 blink if the host device 4 is writing or reading data. The controller 128, for example, may also make the LED 55 emit different colors depending on whether the mode is the recharge mode or the discharge mode. Moreover, information for identifying whether the battery 41 is being recharged or is fully charged and information for identifying the capacity of the battery 41 may also be displayed.

In the PHD system that is configured in the manner described above and shown in Fig. 1, when the adapter 2 is connected to the PHD unit 1, the engagement protrusion 48 on the side of the adapter 2 is engaged with the engagement recess 14 on the side of the PHD unit 1, and the first connector 10 on the side of the PHD unit 1 and the second connector 43 on the side of the adapter 2 are thus connected. Then, with the positioning protrusion 50 on the side of the adapter 2 engaged with the positioning hole 16 on the side of the PHD unit 1 and the second housing 40 positioned in relation to the first housing 8, the rotative operation section 51a of the screw member 51 provided on the side of the adapter 2 is rotationally operated, the screw section 51b is screwed into the screw hole 17a of the fixing plate 17 provided on the side of the PHD unit 1, and the second housing 40 is fixed to the first housing 8. Thus, a state where the adapter 2 is attached to the PHD unit 1 is maintained.

The first connector 10 on the side of the PHD unit 1 is attached within the plane of the opening 15 of the first housing 8 in a semi-fixed state with some allowance for movement. On the other hand, the second

connector 43 on the side of the adapter 2 is attached in a fixed state where it is engaged with the opening 49 of the second housing 40. Thus, in this PHD system, it is possible to suitably connect the first connector 10 and the second connector 43 without positioning them precisely, and damage to the connectors upon connecting can be prevented, while the connective reliability of the first connector 10 and the second connector 43 can also be improved.

In addition, in this PHD system, as shown in Fig. 12, the protruding section 52 formed on the connection plane 40c where the second connector 43 of the adapter 2 faces outward is brought into contact with the connection plane 8c from which the first connector 10 of the PHD unit 1 faces outward. Thus, the second housing 40 is at a slight angle with respect to the first housing 8 such that one side of each of the connection planes 8c and 40c are closer to each other and the other side of each of the connection planes 8c and 40c are spaced further apart from each other. Consequently, even if the housings 8 and 40 are fixed to one side of the connectors of the connection planes 8c and 40c, it is possible to prevent the positioning protrusion 50 from falling out from the positioning hole 16 formed to the other side of the connectors of the connection planes 8c and 40c, and suitably maintain a state where the first housing 8 and the second housing 40 are fixed.

Thus, in this PHD system, the PHD unit 1 and the adapter 2 can be integrated into a single unit with a simple structure without adopting a structure in which the connection planes are fixed to each other to both sides of the first connector 10 and the second connector 43. Hence, further miniaturization can be attained.

Also, in this PHD system, as shown in Fig. 1, when the PHD unit 1 and the adapter 2 are integrated into a single unit, the first displaying section 18 and the second displaying section 54 form a continuous and linear displaying section between the first housing 8 and the second housing 40, thereby making aesthetically superior display possible. Also, it helps to prevent the erroneous connection of the adapter 2 and the PHD unit 1,

thereby improving the ease of use.

This PHD system is electrically connected to, for example, a notebook personal computer 4, which is a host device, via the connection cable 5 in a condition where the adapter 2 and the PHD unit 1 are connected.

5 Thus, data is written to and read from the host device 4.

In this PHD system, since power can be supplied to the PHD unit 1 from the battery 41 in the adapter 2, or from an external power source by having the plug of an AC adapter connected to the power source jack 45, and not just from the host device 4 via the power line of a USB compliant  
10 interface, even if the PHD unit 1 includes an HDD 9 of a high capacity, it is possible to stabilize the driving of this PHD unit 1, and to prevent a drop in performance.

The cradle 3, which together with the above-mentioned PHD unit 1 forms part of the PHD system shown in Fig. 2, will be described below.

15 As shown in Figs. 13 and 14, this cradle 3 is provided with: a second housing 61 including a mounting section 60 in which the PHD unit 1 is set; a first circuit board 62 and a second circuit board 63 that are accommodated in the second housing 61; a second connector 64 that is mounted on the first circuit board 62 and faces outward from a bottom plane 60a of the mounting  
20 section 60; a first USB connector 65, a second USB connector 66, a third USB connector 67 and a power source jack 68 that are mounted on the second circuit board 63 and face outward from the rear side of the second housing 61; a first pair of upper and lower electro-magnetic shielding plates 69 for shielding the first circuit board 62; and a second pair of upper and  
25 lower electro-magnetic shielding plates 70 for shielding the second circuit board 63.

The second housing 61 has a structure where it is divided into a front panel 61a, a center panel 61b, a back panel 61c and a bottom panel 61d. Each of the panels is formed by injection molding a resin material. Then,  
30 this second housing 61 is joined and integrated with a plurality of screws (not shown) while they are fitted with one another.

The mounting section 60 is comprised of the front panel 61a and the center panel 61b. A concave section corresponding in shape to the first housing 8 is formed so that the PHD unit 1 fits nicely. An engagement protrusion 60e, which engages with the engagement recess 14 of the PHD unit 1 mentioned above, is formed on the bottom plane 60a of this mounting section 60. Also, an opening 71 from which the second connector 64 faces outward is formed on the inner side of this engagement protrusion 60e, and the second connector 64 is attached such that it is engaged with this opening 71, that is, the second connector 64 is fixed.

In addition, as shown in Figs. 14 and 15, a lock mechanism 72 for maintaining a state where the PHD unit 1 is set in this mounting section 60 is formed on the rear side 60b of the mounting section 60 for supporting the rear side of the PHD unit 1.

As shown in Figs. 13, 14 and 15, this lock mechanism 72 has: an engagement member 73 serving as a second engagement section that engages with the engagement recess section 19 of the PHD unit 1 mentioned above; and a spring member 74 for biasing this engagement member 73 in the direction in which it engages with the engagement recess section 19.

The engagement member 73 is comprised of an elongate member, and has: a pair of shafts 73a, on one end side of the elongate member, pivotally supported by a pair of bearing sections 75 formed on the center panel 61b and the back panel 61c; an engagement protrusion 73b, on the other end side of the elongate member, that is exposed from the rear side 60b of the mounting section 60 through the opening 76 formed in the center panel 61b; and, at the middle section of the elongate member, a pair of spring support pieces 73c onto which the spring member 74 is hooked. By having the pair of shafts 73a pivotally supported by the pair of bearing sections 75, the engagement member 73 is so supported as to be movable between a position where the engagement protrusion 73b is engaged with the engagement recess section 19b of the PHD unit 1 set in the mounting section 60 and a position where the engagement with the engagement recess

section 19 of this PHD unit 1 is undone.

The spring member 74 has the pair of shafts 73a of the engagement member 73 inserted into a pair of coiled sections 74a that are formed by having a wire material coiled, and both ends 74b of the wire material that  
5 are extended from this pair of coiled sections 74a and are elastically displaceable are hooked onto the pair of spring support pieces 73c of the engagement member 73. This spring member 74 is positioned under a condition where an elastically displaceable middle section 74c, which has a predetermined angle with respect to both ends 74b hooked onto the pair of  
10 spring support pieces 73c of the engagement member 73, is in contact with the back panel 61c. Consequently, the spring member 74 biases the engagement member 73 in the direction in which the engagement protrusion 73b is exposed from the rear side 60b of the mounting section 60 through the opening 76 in the center panel 61b.

15 In addition, with this lock mechanism 72, by having the engagement protrusion 73b of the engagement member 73 engaged with the engagement recess section 19 of the PHD unit 1 when the PHD unit 1 is set in the mounting section 60, it is possible to maintain a state where the PHD unit 1 is set in the mounting section 60, and to prevent the PHD unit 1 from being  
20 detached from the mounting section 60 during operation.

In addition, an unlocking mechanism 77 for unlocking the locked state of the PHD unit 1 by the above-mentioned lock mechanism 72 is provided in the second housing 61.

This unlocking mechanism 77 has: an operation button 78 that faces  
25 outward from one side section of the second housing 61; an operation member 79 that is operated by pressing this operation button 78; and a compression coil spring 80 for biasing this operation member 79 in a predetermined direction so that the operation button 78 protrudes from the second housing 61. Moreover, the operation member 79 has: a switching  
30 protrusion 79a for operating a switch 81, which is formed on the first circuit board 62 and serves as a switching means for switching the electrical

connection between the PHD unit 1 and the host device 6; a sliding operation section 79b that is slid and operated while in engagement with the other end side of the engagement member 73; and an arm section 79c that links the switching protrusion 79a and the sliding operation section 79b.

5           Then, in this unlocking mechanism 77, as shown in Fig. 16, the operation button 78 is pushed against the biasing force of the compression coil 80 so that the switching protrusion 79a of the operation member 79 operates the switch 81, thereby cutting the electrical connection between the PHD unit 1 and the host device 6. Then, as shown in Fig. 17, while the  
10       sliding operation section 79b of the operation member 79 is engaged with the other end side of the engagement member 73, the engagement protrusion 73b of the engagement member 73 is moved in a predetermined direction so that the engagement with the engagement recess section 19 of the PHD unit 1 set in the mounting section 60 is undone. Consequently, the locked state  
15       of the PHD unit 1 by the lock mechanism 72 mentioned above is undone. In other words, with this unlocking mechanism 77, the electrical connection between the PHD unit 1 and the host device 6 can be cut before the engagement between the engagement protrusion 73b of the engagement member 73 and the engagement recess section 19 of the PHD unit 1 is  
20       undone by having the switching protrusion 79a of the operation member 79 operate the switch 81.

As shown in Fig. 13, a pair of guide protrusions 82 serving as second guide sections to be engaged with the pair of guide grooves 20 in the PHD unit 1 mentioned above is formed on both side sections 60c of the mounting  
25       section 60. The pair of guide protrusions 82 is formed along both of the side sections 60c from the end on the side of the bottom plane 60a of the mounting section 60.

In addition, a second displaying section 83 is formed on the principal surface of the front panel 61a. This second displaying section 83 is devised  
30       so as to conceal gate marks generated when the front panel 61a is injection molded. In other words, a gate mark is generated in approximately the

center of the front panel 61a. However, by forming the second displaying section 83 at such a position that this gate mark would be covered, the design is improved. In addition, this second displaying section 83 is formed in a substantially linear manner from where this gate mark is formed  
5 towards the end on the side of the mounting section 60. Also, an LED (Light Emitting Diode) 84 that indicates a state where the PHD unit 1 is mounted on the cradle 3, the operative status of the PHD unit 1 and the like is provided on this second displaying section 83. Moreover, on the bottom panel 61d, a plurality of rubber pads (not shown) serving as slip stoppers is  
10 provided in the corner sections.

The second connector 64 mounted on the first circuit board 62 is a female connector corresponding to the interface on the side of the PHD unit 1 that complies with the signal pin arrangement of the above-mentioned IDE standard. By being connected to the first connector 10 of the PHD unit  
15 1 mentioned above, the second connector 64 is able to supply power to the PHD unit 1, and transmit and receive data to and from the PHD unit 1.

The first USB connector 65 mounted on the second circuit board 63 is a transmission/reception unit corresponding to the interface on the side of the host device 6 that complies with, for example, the USB standard, and it  
20 is provided so as to face outward from the rear side of the back panel 61c. By being connected to the host device 6 via the connection cable 7, the first USB connector 65 is able to receive power from the host device 6, and transmit and receive data to and from the host device 6.

In addition, this second circuit board 63 includes an interface  
25 conversion circuit (IDE/USB conversion circuit) serving as an interface converter for carrying out, between the above-mentioned second connector 64 and first USB connector 65, interface conversion between the interface on the side of the PHD unit 1 (IDE) and the interface on the side of the host device 6 (USB). Thus, power can be supplied from the host device 6 to the  
30 PHD unit 1, and data can be written to and/or read from the PHD unit 1.

In addition, the second USB connector 66 and the third USB

connector 67 mounted on the second circuit board 63 are alternate transmission/reception units that comply with, for example, the USB standard, and they are provided so as to face outward from the back panel 61c. By being connected to an electronic device other than the host device 6,  
5 the second USB connector 66 or the third USB connector 67 is able to supply power to that electronic device, and transmit and receive data with that electronic device.

In addition, the power source jack 68 mounted on the second circuit board 63 is provided such that it faces outward from the rear side of the back  
10 panel 61c and is alongside the above-mentioned first USB connector 65. Also, by having the plug of an AC adapter connected thereto, the power source jack 68 is able to supply power from the external power source to the PHD unit 1.

In addition, this second circuit board 63 includes a control circuit for  
15 controlling the supplying of power to the PHD unit 1. Thus, it is possible to stabilize the driving of the PHD unit 1.

The first pair of upper and lower electro-magnetic shielding plates 69 and the second pair of electro-magnetic shielding plates 70 are made of approximately rectangular metal plates corresponding in shape to the first  
20 circuit board 62 and the second circuit board 63. They shield both principal surfaces of the first circuit board 62 and the second circuit board 63, and are grounded in relation to the first circuit board 62 and the second circuit board 63. Also, the first pair of upper and lower first electro-magnetic shielding plates 69 and the second pair of upper and lower electro-magnetic shielding  
25 plates 70 shield the first circuit board 62 and the second circuit board 63 in a state where a plurality of bent pieces 85 and 86 bent along the first circuit board 62 and the second circuit board 63 overlap each other. Thus, electro-magnetic waves radiated from the first circuit board 62 and the second circuit board 63 can be suitably shielded inside the second housing 61.  
30 Also, the first pair of upper and lower electro-magnetic shielding plates 69 and the second pair of electro-magnetic shielding plates 70 have a plurality



of slits 85a and 86a formed in the bent pieces 85 and 86 along the direction in which they are bent, thereby improving contact between the bent pieces 85 and 86, and further improving the shielding effect for electro-magnetic waves.

5           In addition, each of the panels of the second housing 61 can be made lighter by using plastic cases formed by injection molding a resin material. Moreover, a conductive layer comprised of a conductive film or the like may be formed on at least one of the main surface of the panel facing the first electro-magnetic shielding plates 69 or the second electro-magnetic  
10   shielding plates 70 and the main surface opposite that main surface. This makes it possible to further improve the shielding effect for electro-magnetic waves. Alternatively, each of the panels of the second housing 61 may be formed by injection molding a resin material in which a conductive filler is contained. In this case, it is possible to improve the shielding effect for  
15   electro-magnetic waves without having to provide an additional component.

The electrical configuration of the cradle 3 will be described below.

The cradle 3 includes a USB hub circuit 131, an IDE interface (I/F) circuit 132 and a USB/IDE conversion circuit 133, as shown in Fig. 18.

The USB hub circuit 131 is an interface circuit for transmitting and  
20   receiving data in USB format to and from the host device 6 via the first USB connector 65, the second USB connector 66 and the third USB connector 67. The plurality of USB connectors 65 to 67 are connected to the USB hub circuit 131, and any of the connectors may be connected to the host device 6. Also, the USB hub circuit 131 has a so-called hub function. If a device  
25   other than the host device 6 is connected to one of the first to third USB connectors 65 to 67, it mediates the transmission and reception of data between the host device 6 and that other device. The IDE interface circuit 132 is an interface circuit for transmitting and receiving data in IDE format to and from the PHD unit 1 through the second connector 64. The  
30   USB/IDE conversion circuit 133 is a circuit for carrying out the conversion of data in USB format into data in IDE format and vice versa.

In the cradle 3 having such a configuration, the USB hub circuit 131 receives data in USB format transferred through any of the first to third USB connectors 65 to 67 from the host device 6. The USB hub circuit 131 transfers the data in USB format received from the host device 6 to the USB/IDE conversion circuit 133. The USB/IDE conversion circuit 133 converts the data in USB format transferred from the USB hub circuit 131 into IDE format data, and transfers it to the IDE interface circuit 132. The IDE interface circuit 132 transfers the data in IDE format to the PHD unit 1 through the second connector 64. Thus, with the cradle 3, data received in USB format from the host device 6 can be converted into IDE format data and transferred to the PHD unit 1. Then, that data can be recorded on the hard disk 24 in the PHD unit 1.

In addition, in the cradle 3, the IDE interface circuit 132 receives data in IDE format transferred from the PHD unit 1 through the second connector 64. The IDE interface circuit 132 transfers the data in IDE format received from the PHD unit 1 to the USB/IDE conversion circuit 133. The USB/IDE conversion circuit 133 converts the data in IDE format transferred from the IDE interface circuit 132 into data in USB format, and transfers it to the USB hub circuit 131. The USB hub circuit 131 transmits the data in USB format to the host device 6 through any of the first to third USB connectors 65 to 67. Thus, with the cradle 3, data in IDE format read from the hard disk 24 in the PHD unit 1 can be converted into USB format data and transmitted to the host device 6.

In addition, the cradle 3 includes a DC/DC converter 134 for supplying power to the PHD unit 1.

The DC/DC converter 134 is a direct current voltage conversion circuit, such as a so-called switching converter and the like, and can generate a voltage stabilized at a predetermined value regardless of the load. The direct current voltage (VCC) outputted from the DC/DC converter 134 is supplied, as direct current power that is IDE compliant, to the PHD unit 1 through the second connector 64 along with data that is inputted and

outputted through the IDE interface circuit 132.

The power supplied to this DC/DC converter 134 is external power (V\_IN) inputted from an external power source (for example, a conversion apparatus for converting AC power into DC power). The power source jack  
5 68 is connected to an input terminal of the DC/DC converter 134 through a switch 81 and a diode 135. The diode 135 has its cathode connected to the input terminal of the DC/DC converter 134, thereby preventing counter currents to the external power source. Thus, when an external power source is connected, external power (V\_IN) is supplied to the DC/DC  
10 converter 134.

In addition, the switch 81 is a switch that is turned on and off in conjunction with the unlocking mechanism 77 and cuts the supplying of power to the PHD unit 1. The switch 81 is turned on (closed) when the PHD unit 1 is connected to the cradle 3. However, it is turned off (opened)  
15 when the user presses the operation button 78 and removes the PHD unit 1 from the cradle 3. Moreover, this switch 81 has a mechanism where it is turned off before the first connector 10 and the second connector 64 are released. Thus, by virtue of this switch, the supplying of power to the PHD unit 1 is always stopped before the PHD unit 1 is removed from the cradle 3.

Along with pins corresponding to the transmission line required of an IDE interface, the second connector 64 is provided with first and second USB power source pins 136 and 137 not required of an IDE interface bus. The first USB power source pin 136 is connected to a USB power line, which is a power line defined in the USB standard, via the USB hub circuit 131.  
20 The second USB power source pin 137 is connected to a controller 138.

The first and second USB power source pins 136 and 137 are connected to the first and second USB power source pins 107 and 108 on the side of the PHD unit 1, respectively, when the PHD unit 1 is mounted on the cradle 3, that is, when the first connector 10 and the second connector 64 are  
30 connected. The first and second USB power source pins 107 and 108 on the side of the PHD unit 1 are short-circuited by the jumper cable 106 inside the

PHD unit 1. Thus, when the PHD unit 1 is mounted on the cradle 3, the first USB power source pin 136 and the second USB power source pin 137 are electrically connected. Thus, USB power (V\_USB) is supplied to the DC/DC converter 134 when the PHD unit 1 is mounted on the cradle 3 and the host device 6 and the cradle 3 are connected through the USB cable 7.

The controller 138 controls the supplying of power to the USB hub circuit 131, the IDE interface circuit 132, the USB/IDE conversion circuit 133, the DC/DC converter 134 and the like. Also, the second USB power source pin 137 of the second connector 64 is connected to the controller 138. The controller 138 judges the state of the voltage of this second USB power source pin 137, and carries out the above-mentioned control of power supply. Also, the controller 138 carries out drive control for the LED 84.

The power supply operation of the cradle 3 having the above-mentioned configuration, and the various control operations will be described below.

The cradle 3 is a system in which switching control of power supply is performed in accordance with apparatus connection where power is not supplied unless the host device 6 and the PHD unit 1 are securely connected. The controller 138 detects the voltage of the second USB power source pin 137 of the second connector 64. When the voltage is detected, the controller 138 carries out power supply control to the USB hub circuit 131, the IDE interface circuit 132, the USB/IDE conversion circuit 133 and the like. By carrying out such control, the cradle 3 becomes a system that does not supply power unless the host device 6 and the PHD unit 1 are securely connected. Thus, with the cradle 3, for example, even if only an external power source is connected, or even if a cable which should not have been connected is erroneously connected, there is no risk that unusual power related circumstances would occur. A switch for turning external power (V\_IN) from the power source jack 68 on and off may be provided, and such control where that switch is turned on when the voltage of the second USB power source pin 137 is detected may be performed.

The controller 138 can notify the user of the operative status of the cradle 3 by carrying out display control of the LED 84. For example, the controller 138 may turn on the LED 84 if the host device 6 and the PHD unit 1 are connected to the cradle 3. In addition, the controller 138 may, for example, watch for a communication flag (a flag generated when data is being transferred) generated by the USB/IDE conversion circuit 133, and make the LED 84 blink if the host device 6 is writing or reading data.

In the PHD system that is configured as mentioned above and shown in Fig. 2, when the PHD unit 1 is mounted on the mounting section 60 of the cradle 3, first, the guide grooves 20 on the side of the PHD unit 1 and the guide protrusions 48 on the side of the mounting section 60 are engaged with each other, and the PHD unit 1 is guided while being mounted on the mounting section 60 of the cradle 3. Then, if the PHD unit 1 is mounted on the mounting section 60 of the cradle 3, the engagement protrusion 60e on the side of the mounting section 60 is engaged with the engagement recess 14 on the side of the PHD unit 1, and the first connector 10 on the side of the PHD unit 1 and the second connector 64 on the side of the adapter 2 are connected. Also, by having the engagement protrusion 73b of the engagement member 73 engaged with the engagement recess section 19 on the side of the PHD unit 1, a state where the PHD unit 1 is set in the mounting section 60 is suitably maintained.

The first connector 10 on the side of the PHD unit 1 is attached within the plane of the opening 15 of the first housing 8 in a semi-fixed state with some allowance for movement. On the other hand, the second connector 64 on the side of the mounting section 60 is attached in a fixed state where it is engaged with the opening 71 of the second housing 61. Thus, in this PHD system, it is possible to suitably connect the first connector 10 and the second connector 64 without positioning them precisely, and damage to the connectors upon connecting can be prevented, while the connective reliability of the first connector 10 and the second connector 64 can also be improved.

In addition, in this PHD system, as shown in Fig. 2, when the PHD unit 1 is mounted on the mounting section 60 of the cradle 3, the first displaying section 18 and the second displaying section 83 form a continuous and linear displaying section between the first housing 8 and the second housing 61, thereby making aesthetically superior display possible. Also, it helps to prevent erroneous connection when the PHD unit 1 is mounted on the mounting section 60 of the cradle 3, thereby improving the ease of use.

This PHD system is electrically connected to, for example, a desktop personal computer 6, which is a host device, via the connection cable 7 in a condition where the PHD unit 1 is mounted on the mounting section 60 of the cradle 3. Thus, data is written to and read from the host device 6.

In this PHD system, since power can be supplied to the PHD unit 1 from an external power source by having the plug of an AC adapter connected to the power source jack 68, and not just from the host device 6 via the power line of a USB compliant interface, even if the PHD unit 1 includes an HDD 9 of a high capacity, it is possible to stabilize the driving of this PHD unit 1, and prevent a drop in performance.

In addition, in this PHD system, by pressing the operation button 78 of the unlocking mechanism 77 in removing the PHD unit 1 from the mounting section 60 of the cradle 3, the switching protrusion 79a of the operation member 79 operates the switch 81 on the first circuit board 62 and cuts the electrical connection between the PHD unit 1 and the host device 6 before the engagement between the engagement protrusion 73b of the engagement member 73 and the engagement recess section 19 of the PHD unit 1 is undone. Thus, it is possible to protect the PHD unit 1.

As mentioned above, in the PHD systems shown in Figs. 1 and 2, the combination of the PHD unit 1 and the adapter 2 or the cradle 3 can be altered easily depending on the usage. Also, in this PHD system, the PHD unit 1 can be easily replaced with respect to the adapter 2 or the cradle 3, and this PHD unit 1 itself can be carried freely. Also, this PHD unit 1 may be miniaturized so that it can be handled with ease as a portable recording

medium.

Although in the above-mentioned PHD system, a configuration is adopted where the first connector 10 on the side of the PHD unit 1 is semi-fixed, and the second connectors 43 and 64 on the side of the adapter 2 and the cradle 3 are fixed, it is also possible to adopt a configuration where the first connector 10 on the side of the PHD unit 1 is fixed, and the second connectors 43 and 64 on the side of the adapter 2 and the cradle 3 are semi-fixed.

In other words, the first connector 10 is fixed in place by being engaged with the opening 15 of the first housing 8 as mentioned above. On the other hand, the second connectors 43 and 63 are semi-fixed in the planes of the openings 49 and 71, respectively, by being engaged with the openings 49 and 71 of the second housings 40 and 61 with some allowance for movement as mentioned above.

Thus, in the PHD system, it is possible to suitably connect the first connector 10 and the second connectors 43 and 64 without positioning them precisely, and prevent damage to the connectors upon connection, while at the same time improving the connective reliability between the first connector 10 and the second connectors 43 and 64.

In the present invention, the interface between the adapter 2 and the cradle 3 and the host devices 4 and 6 is not limited to a USB compliant interface, and it is possible to adopt an interface that complies with IEEE (Institute of Electrical and Electronics Engineers) 1394, ATA/ATAPI (Advanced Technology Attachment/Package Interface), SCSI (Small Computer System Interface), PC Card and the like. Also, in the present invention, the interface between the adapter 2 and the cradle 3 and the host devices 4 and 6 is not limited to a wired interface using a connection cable, and may be one that is connected through a transmission/reception unit that complies with IEEE 802.11b (wireless LAN), Bluetooth (short range wireless communications) and the like.

Since the invention disclosed herein may be embodied in other specific forms without departing from the spirit or general characteristics thereof, some of which forms have been indicated, the embodiments described herein are to be considered in all respects illustrative and not  
5 restrictive. The scope of the invention is to be indicated by the appended claims, rather than by the foregoing description, and all changes which come within the meaning and range of equivalents of the claims are intended to be embraced therein.